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FORM PTO-1390 (REV. 9-2001) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: **306.41247X00 filed March 1, 2002**

U S APPLICATION NO (If known, see 37 CFR 1 5): **10/069877**

INTERNATIONAL APPLICATION NO	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP00/08427	**August 20,2000**	**September 11, 1999**

TITLE OF INVENTION
CARBON-FIBRE-REINFORCED SMC FOR MULTI-AXIALLY REINFORCED COMPONENTS

APPLICANT(S) FOR DO/EO/US
EHNERT, GERD BIENIEK, KLAUS

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2)))
   a. ☐ is transmitted hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office(RO/US)
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☒ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information: **Figs. 1-7, Credit Card Payment Form, International Preliminary Examination Report, PCT Request Form, Internation Publication Number WO 01/19599**

U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 10/069877	INTERNATIONAL APPLICATION NO. PCT/EP00/08427	ATTORNEY'S DOCKET NUMBER 306.41247X00

21. The following fees are submitted

BASIC NATIONAL FEE (37 CFR 1.492(a) (1) - (5)):

	CALCULATIONS PTO USE ONLY
☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**	
☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**	
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**	
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4). **$710.00**	
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4)..... **$100.00**	

ENTER APPROPRIATE BASIC FEE AMOUNT =				**$890.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	$	
Total Claims	**26** - 20 =	**6**	x **$18.00**	**$108.00**	
Independent Claims	**1** - 3 =	**0**	x **$84.00**	$	
MULTIPLE DEPENDENT CLAIMS(S) (if applicable)			+ **$280.00**	$	
TOTAL OF ABOVE CALCULATIONS =				**$998.00**	
☐ Applicant claims small entity status See 37 CFR 1.27. The fees indicated above are reduced by ½.				$	
SUBTOTAL =				**$998.00**	
Processing fee of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f))				$	
TOTAL NATIONAL FEE =				**$998.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
TOTAL FEES ENCLOSED =				**$998.00**	
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a. ☐ A check in the amount of $_____ to cover the fees is enclosed

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NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO

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SIGNATURE

Alan E. Schiavelli
NAME

32,087
REGISTRATION NO

612.41247X00

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: EHNERT et al

Serial No.:

Filed: March 1, 2002

For: Carbon-Fibre-Reinforced SMC For Multi-Axially Reinforced Components

Group:

Examiner:

PRELIMINARY AMENDMENT

Assistant Commissioner
for Patents
Washington, D.C. 20231

March 1, 2002

Sir:

Prior to examination on the merits of this application and prior to calculation of the filing fee, please amend the above-identified application as follows:

IN THE CLAIMS:

Please amend the claims to read as follows:

6. (Amended) SMC according to Claim 1, characterised in that the UD fibres (7) are shortened by incisions in the finished SMC to produce flowability in the fibre direction.

8. (Amended) SMC according to Claim 1, characterised in that a different resin matrix (2) is used for the random fibres (4) and the UD fibres (7).

9. (Amended) SMC according to Claim 1, characterised in that, to check the UD fibre directions, individual UD glass fibres are introduced into the matrix (2) in the

direction of the UD carbon fibres (7) as contrast fibres.

10. (Amended) SMC according to Claim 1, characterised in that the SMC weight per unit area is less than 1000 gram/m^2.

11. (Amended) SMC according to Claim 1, characterised in that the resin matrix (2) contains electrically conductive additives.

12. (Amended) Process for producing a fibre-reinforced SMC according to Claim 1, characterised

- in that SMC mats with a single layer of UD fibres (7) are produced

and

- in that a plurality of SMC mats is arranged, prior to further processing to form the component (16), with multi-axial alignment of the UD fibres (7) by building up into a stack (19).

14. (Amended) Process according to Claim 12, characterised in that at least four UD fibre layers (7) are arranged.

16. (Amended) Process according to Claim 12, characterised in that at least six UD fibre layers (7) are arranged.

18. (Amended) Process according to Claim 12, characterised in that eight UD fibre layers (7) are arranged.

20. (Amended) Process according to Claim 12, characterised

- in that the SMC mats are cut into strips (12) and would onto spools or reels (8),

- in that the strips (12) are cut to length and arranged in rectangular blank layers

and

- in that the individual blank layers (11) are built up into a stack (19) on a rotary

table (14).

23. (Amended) Process according to Claim 1, characterised in that the strips (12) are wound onto spools with a core diameter of greater than 200 mm and an outside diameter of greater than 500 mm.

24. (Amended) Process according to Claim 1, characterised in that the SMC is flowable and the blank size is always smaller than the laid out component surface.

25. (Amended) Component made of fibre-reinforced thermosets, characterised in that this component is produced from an SMC according to Claim 1.

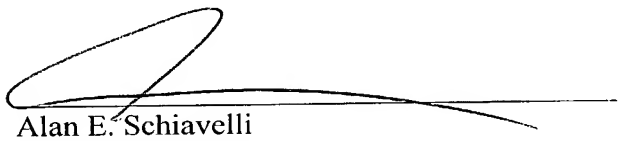
REMARKS

The foregoing amendments are respectfully requested prior to examination on the merits of this application. A marked up copy of the amended claims is attached.

To the extent necessary, applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in the fees due in connection with the filing of this paper, including extension of time fees, to the deposit account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (Case: 612.41247X00), and please credit any excess fees to such deposit account.

Respectfully submitted,

ANTONELLI, TERRY, STOUT & KRAUS, LLP



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6. (Amended) SMC according to ~~one of Claims 1 to 5~~ Claim 1, characterised in that the UD fibres (7) are shortened by incisions in the finished SMC to produce flowability in the fibre direction.

8. (Amended) SMC according to ~~one of the preceding claims~~ Claim 1, characterised in that a different resin matrix (2) is used for the random fibres (4) and the UD fibres (7).

9. (Amended) SMC according to ~~one of the preceding claims~~ Claim 1, characterised in that, to check the UD fibre directions, individual UD glass fibres are introduced into the matrix (2) in the direction of the UD carbon fibres (7) as contrast fibres.

10. (Amended) SMC according to ~~one of the preceding claims~~ Claim 1, characterised in that the SMC weight per unit area is less than 1000 gram/m^2.

11. (Amended) SMC according to ~~one of the preceding claims~~ Claim 1, characterised in that the resin matrix (2) contains electrically conductive additives.

12. (Amended) Process for producing a fibre-reinforced SMC according to ~~one of Claims 1 to 11~~ Claim 1, characterised

- in that SMC mats with a single layer of UD fibres (7) are produced

and

- in that a plurality of SMC mats is arranged, prior to further processing to form the component (16), with multi-axial alignment of the UD fibres (7) by building up into a stack (19).

14. (Amended) Process according to Claim 12 ~~or 13~~, characterised in that at least four UD fibre layers (7) are arranged.

16. (Amended) Process according to Claim 12 ~~or 13~~, characterised in that at

least six UD fibre layers (7) are arranged.

18. (Amended) Process according to Claim 12 ~~or 13~~, characterised in that eight UD fibre layers (7) are arranged.

20. (Amended) Process according to ~~one of Claims 12 to 19~~ Claim 12, characterised

- in that the SMC mats are cut into strips (12) and would onto spools or reels (8),
- in that the strips (12) are cut to length and arranged in rectangular blank layers and
- in that the individual blank layers (11) are built up into a stack (19) on a rotary table (14).

23. (Amended) Process according to ~~one of the preceding claims~~ Claim 1, characterised in that the strips (12) are wound onto spools with a core diameter of greater than 200 mm and an outside diameter of greater than 500 mm.

24. (Amended) Process according to ~~one of the preceding claims~~ Claim 1, characterised in that the SMC is flowable and the blank size is always smaller than the laid out component surface.

25. (Amended) Component made of fibre-reinforced thermosets, characterised in that this component is produced from an SMC according to ~~one of Claims 1 to 24~~ Claim 1.

7/pats

Carbon-fibre-reinforced SMC for multi-axially reinforced components

The invention relates to an SMC for producing fibre-reinforced thermosetting components, a corresponding production process and a component produced from this SMC.

SMC stands for "Sheet Moulding Compound" and is a resin mat according to DIN 16913. In general, SMC refers to a flowable resin mat based on unsaturated polyester resin or vinyl ester resin and random fibre distribution in the plane of the mat. The reinforcing fibres customarily used are glass fibres. A typical SMC formulation consists of about 30% of polymer, about 30% of filler and about 30% of glass fibres, the remainder being composed of additives, such as, for example, colouring pigments, hardeners, dispersing auxiliaries, fillers and similar materials. SMC is generally produced as follows: the resin matrix is applied to two carrier films. These carrier films are drawn through an SMC machine and in the process transport the resin matrix, onto which the reinforcing fibres are sprinkled or laid. Once the reinforcing fibres have been deposited, the two films are pressed together to produce a kind of sandwich. This sandwich is transported through an impregnating section, which uses pushing and rocking movements to ensure that the fibres are uniformly wetted with the resin matrix. At the end of the machine, it is wound onto reels. Of crucial importance is a ripening process, which may be initiated by chemical and/or physical means. After this ripening process, the SMC can be further processed. After stripping off of the carrier foils, the SMC is customarily processed or pressed in heated steel moulds to form shaped parts.

The advantage of SMC is the high flowability, which has the effect that only 30 to 50% of the pressing mould has to be covered. The strength and stiffness can be varied in a wide range, depending on the reinforcing-fibre content.

As an alternative, it is known to place a woven fabric in the resin matrix for reinforcement. The disadvantage of this is that, although the strength is substantially increased, there is hardly any flowability. The pressing mould must be completely covered, which requires exact cutting to size, resulting in a lot of waste.

Furthermore, SMC with a glass-fibre reinforcement comprising both cut fibres (random fibres) and unidirectional fibres (UD fibres) is known. The UD fibres produce increased strength and stiffness properties in an axial direction and the random fibres determine the transverse strength. This SMC is preferably employed only for support-type components, such as, for example, bumper supports. It is not possible to produce sheet-like components because of the high tendency of the components to become distorted.

The object on which the invention is based is to develop an SMC for producing fibre-reinforced thermosetting components according to the preamble such that a high strength and stiffness in a multi-axial direction is achieved in sheet-like thin-walled components. The basis for this is an SMC with an asymmetrical fibre structure, comprising a random fibre side and a UD fibre side.

According to the invention, this object is achieved in that several layers of SMC containing UD fibres with a different axial alignment from one another are arranged

in the component. Since the UD fibres govern the strength and stiffness properties, these properties are not only provided in an axial direction but in different directions. Owing to the high strength and stiffness, it is possible to produce lightweight components or ones with a thin wall structure.

In order to be able to produce a multi-layer SMC structure with desired component wall thicknesses of about 1.2 mm and large SMC as cut dimensions, the SMC weight per unit area must be less than 1000 g/m^2.

Until now, it has not been possible either to produce such low SMC weights per unit area industrially, or effectively from the point of view of strength and stiffness. The development of such an SMC has become interesting only with a UD carbon-fibre reinforcement and the resulting strength and stiffness properties for a multi-axial reinforcement in the component.

In comparison with the customary process techniques for the production of components from fibre composites with carbon fibres (resin transfer moulding, prepreg processing by the pressing or autoclave process), the SMC on which the invention is based has the following advantages:

- Simple as cut geometries, since despite UD fibre reinforcement the SMC is flowable

- No SMC clippings which have to be disposed of or recycled

- No trimming of the shaped parts, therefore no waste

- Short cycle times of the component production, therefore suitable for mass production.

A combination of random fibres formed of glass or carbon fibres with UD carbon fibres is preferred for the asymmetrically reinforced SMC which has been developed.

The SMC on which the invention is based covers 60 - 95% of the pressing mould. In order to produce the flowability of the UD carbon fibres in the UD direction, the continuous UD fibres are cut to a finite length. The finite UD fibre lengths may be between 25 mm and 650 mm. The ends of the finite UD fibres are offset from one another in order to avoid weak points in the SMC.

In a preferred embodiment, the UD fibre lengths are carbon fibre tows, for example produced by the "heavy tow" process. It is advantageous to use carbon fibres greater than 49 K for this purpose. Alternatively, broad-strip carbon fibre tows produced by the "heavy tow" process in widths of 10 mm to 500 mm can be used.

To check the UD fibre directions in the finished shaped part by X-ray inspection, individual glass fibre yarns are introduced into the matrix in the direction of the UD fibres as contrast fibres.

To improve the fibre wetting, the flowability and to compensate for shrinkage, a different resin matrix is advantageously used for the random fibres and the UD fibres.

It is advantageous to introduce conductive additives into the resin matrix, in order to improve the electrical conductivity to such a degree that an

electrostatic (ESTA) coating is possible without an additional conductive primer on the component.

The surface resistance should be between 10 and 10^6 Ω at 5 V and the volume resistance be less than 10^5 Ω/cm.

A process according to the invention for producing a fibre-reinforced SMC having the above-mentioned properties is distinguished in that SMC mats with random fibres and a single layer of UD fibres are produced and in that a plurality of such SMC mats is arranged, prior to further processing to form the shaped part, with multi-axial alignment of the UD fibres by building up into a stack. This has the great advantage that an existing installation for producing an SMC comprising random fibres and UD fibres does not have to be altered. The multi-axial alignment is brought about by the building up of individual SMC mats into a stack, the SMC mats being stacked so as to be rotated relative to one another.

In a preferred embodiment, all the UD fibre layers used are aligned in the 0° direction and any desired number of fibre layers are used.

In an alternative preferred embodiment, at least four UD fibre layers are arranged in the following alignment:

0°, 90°, 90°, 0° or 0°, 90°, 0°, 90°.

The angles indicate that the next UD fibre layer below is arranged so as to be rotated by this angle relative to the first layer.

This means that the first layer is aligned at 0° and the second layer at 90° relative to the first layer.

In an alternative preferred embodiment, at least six UD fibre layers are arranged. In this case, the UD fibre layers expediently have the following alignment:

0°, 90°; +45°, -45°, 90°, 0°.

In an alternative embodiment, eight UD fibre layers are arranged with the following alignment:

0°, 90°; +45°, -45°, +45°, -45°, 90°, 0°.

For greater wall thicknesses, the material structure can be laid from multiples of 4 or 6 or 8 layers in the specified order one above the other.

A preferred embodiment of the process provides that the SMC mats (with one UD fibre layer) are cut into strips and wound onto spools, that the strips for the component production are cut to length and arranged in any desired position and the individual blank layers are built up into a stack in any desired angular position relative to one another on a rotary table. This has the advantage that even geometrically difficult blank shapes do not produce any waste.

As the final operation, the stack is either placed in the tool (press) for producing the component and the component is pressed or else, as an intermediate stage, is preshaped by prepressing for the purpose of securing, the press for preshaping being an inverse form of the mould for producing the component.

Preferably, the strips are wound onto spools with a core diameter of greater than or equal to 200 mm and an outside diameter of greater than or equal to 500 mm.

The SMC and processing technology according to the invention is versatile. It is preferably used to produce fibre-reinforced components, in particular for the automotive industry.

Components can be produced for a wide variety of applications, depending on the resin matrix. Interior and exterior parts joined together result in high strengths and stiffnesses in body elements, for example.

When using a non-shrinking resin matrix, it is possible to produce exterior parts of motor vehicles with a "class A" surface which, because of their electrical conductivity, can be electrostatically coated like sheet-metal parts.

Further features of the invention will become apparent from the figures which are described below and in which:

Fig. 1 shows, schematically, an installation for producing SMC with one UD fibre layer,

Fig. 2 shows, schematically, an apparatus for producing the blank layers and the multi-axial SMC,

Fig. 3 shows, schematically, the production of the blank layers and the building up into a stack on a rotary table,

Fig. 4 shows the pressing to form a shaped part,

Fig. 5 shows, by way of example, a built up stack of individual UD fibre layers,

Fig. 6 shows a finished shaped part with a schematic arrangement of the original UD fibre layers, and

Fig. 7 shows the multi-axial alignment of the UD fibre layers.

Fig. 1 shows a machine or installation for producing SMC with a single UD-fibre layer. A resin paste or resin matrix 2 is applied to a film 1 using a doctor blade 3. Random fibres 4 are then sprinkled on. These random fibres 4 are glass fibres or carbon fibres, which are supplied as continuous fibres 5 to a cutting device 6 and are cut by the latter into small pieces of about 6 - 50 mm in length. Unidirectional UD fibres 7 are then laid on in the direction of travel of the web. These UD fibres 7 are preferably carbon fibres. Finally, a second film 1 is again coated with a resin matrix 2 using a doctor blade 3 and is laid onto the first film, resulting in a kind of sandwich. The subsequent impregnation in a chamber between honeycombs or honeycombs and binders, which may be arranged in a heating chamber, is not shown. This SMC thus produced is, according to the invention, cut on-line or off-line into strips of about 4 - 20 cm in width and wound onto reels.

Fig. 2 shows, schematically, the subsequent procedure. The reels 8 just mentioned are arranged offset in succession. Only two reels 8 are depicted here, by way of example. A film stripper 9 is arranged beside each of the reels 8. To produce the multi-axial SMC, the SMC is

cut to length by a cutting tool 10 and displaced, resulting in a blank layer 11 of virtually any shape without clipping. The reference numeral 12 denotes the individual strips after cutting and before displacement. The displacement takes place on a conveying device 13. The individual layers 11 cut to size are then either built up into a stack with different axial alignment of the UD fibres on a rotary table 14 or else fixed directly by prepressing. The press 15 for preshaping is advantageously an inverse form of the mould for producing the shaped part.

Fig. 3 shows, schematically, the production of the blank layers 11 and the building up into a stack on a rotary table 14. The individual reels 8 are cut, according to requirements, and displaced to form a blank layer 11 and then stacked on a rotary table 14. This procedure does not produce any waste or clippings.

Fig. 4 shows the pressing to form a shaped part 16. A stack of built-up blank layers has been preshaped in a preshaping press 17. This preshaping press 17 is then placed together with the preshaped part into the press 18, the preshaping press is then withdrawn and the shaped part 16 is pressed.

Fig. 5 shows, by way of example, a built-up stack 19 of individual blank layers 11. In this example, the stack 19 consists of six layers with an orientation of the UD fibre layers of 0°, 90°, +45°, -45°, 90°, 0°.

Fig. 6 shows a finished component (shaped part) 16 with a schematic arrangement of the individual UD fibre layers. The building up of the individual cut to size layers 11 can be clearly seen.

Fig. 7 shows the multi-axial alignment of the UD fibre layers at 0°, 90°, +45°, -45°, 90°, 0°.

Claims

1. SMC (Sheet Moulding Compound) for producing fibre-reinforced thermosetting components consisting of a resin matrix (2) which is fibre-reinforced with unidirectional fibres (UD fibres) (7) arranged in axial alignment and advantageously with additional cut fibres (random fibres) (4) arranged in non-aligned manner in the resin matrix (2), characterised in that several layers of SMC containing UD fibres (7) with a different axial alignment from one another are arranged in the component.

2. SMC according to Claim 1, characterised in that the random fibres (4) are glass fibres and the UD fibres (7) are carbon fibres or vice versa.

3. SMC according to Claim 1, characterised in that the UD fibres (7) and the random fibres (4) are carbon fibres.

4. SMC according to Claim 1, characterised in that the UD fibres (7) are carbon fibres and no random fibres (4) are used.

5. SMC according to Claim 1, characterised in that the UD fibres (7) are "heavy tow" carbon fibre tows or "heavy tow" broad-strip carbon fibre tows.

6. SMC according to one of Claims 1 to 5, characterised in that the UD fibres (7) are shortened by incisions in the finished SMC to produce flowability in the fibre direction.

7. SMC according to Claim 6, characterised in that the cutting width of the tool for cutting the UD fibre layers is between 2 mm and 15 mm.

8. SMC according to one of the preceding claims, characterised in that a different resin matrix (2) is used for the random fibres (4) and the UD fibres (7).

9. SMC according to one of the preceding claims, characterised in that, to check the UD fibre directions, individual UD glass fibres are introduced into the matrix (2) in the direction of the UD carbon fibres (7) as contrast fibres.

10. SMC according to one of the preceding claims, characterised in that the SMC weight per unit area is less than 1000 gram/m^2.

11. SMC according to one of the preceding claims, characterised in that the resin matrix (2) contains electrically conductive additives.

12. Process for producing a fibre-reinforced SMC according to one of Claims 1 to 11, characterised

- in that SMC mats with a single layer of UD fibres (7) are produced
and

- in that a plurality of SMC mats is arranged, prior to further processing to form the component (16), with multi-axial alignment of the UD fibres (7) by building up into a stack (19).

13. Process according to Claim 12, characterised in that all the UD fibre layers (7) used are aligned in the 0° direction and any desired number of fibre layers (7) are used.

14. Process according to Claim 12 or 13, characterised in that at least four UD fibre layers (7) are arranged.

15. Process according to Claim 14, characterised in that the four UD fibre layers (7) have the following alignment

0°, 90°, 90°, 0° or 0°, 90°, 0°, 90°.

16. Process according to Claim 12 or 13, characterised in that at least six UD fibre layers (7) are arranged.

17. Process according to Claim 16, characterised in that the six UD fibre layers (7) have the following alignment

0°, 90°; +45°, -45°, 90°, 0°.

18. Process according to Claim 12 or 13, characterised in that eight UD fibre layers (7) are arranged.

19. Process according to Claim 18, characterised in that the eight UD fibre layers (7) have the following alignment

0°, 90°; +45°, -45°, +45°, -45°, 90°, 0°.

20. Process according to one of Claims 12 to 19, characterised

- in that the SMC mats are cut into strips (12) and wound onto spools or reels (8),

- in that the strips (12) are cut to length and arranged in rectangular blank layers (11) and

- in that the individual blank layers (11) are built up into a stack (19) on a rotary table (14).

21. Process according to Claim 20, characterised in that the stack (19) is placed into the mould (press) (18) for producing the component (16) or else is preshaped by prepressing for the purpose of securing.

22. Process according to Claim 21, characterised in that the press for preshaping is an inverse form of the mould for producing the component (16).

23. Process according to one of the preceding claims, characterised in that the strips (12) are wound onto spools with a core diameter of greater than 200 mm and an outside diameter of greater than 500 mm.

24. Process according to one of the preceding claims, characterised in that the SMC is flowable and the blank size is always smaller than the laid out component surface.

25. Component made of fibre-reinforced thermosets, characterised in that this component is produced from an SMC according to one of Claims 1 to 24.

26. Component according to Claim 25 for use as an exterior part of a motor vehicle.

ABSTRACT OF THE DISCLOSURE

The invention relates to an SMC (sheet moulding compound) for producing fibre-reinforced duroplastic components. Said SMC consists of a resin matrix (2) which is fibre-reinforced with unidirectional fibres (UD-fibres) (7) that are arranged in axial alignment and preferably with additional cut fibres (random fibres) (4) that are arranged in a non-aligned manner in the resin matrix. According to the invention, in order to achieve extremely high rigidity in a multi-axial direction with a low surface weight, several layers of SMC are arranged in the component, each layer containing UD-fibres (7) with a different axial alignment from one another.

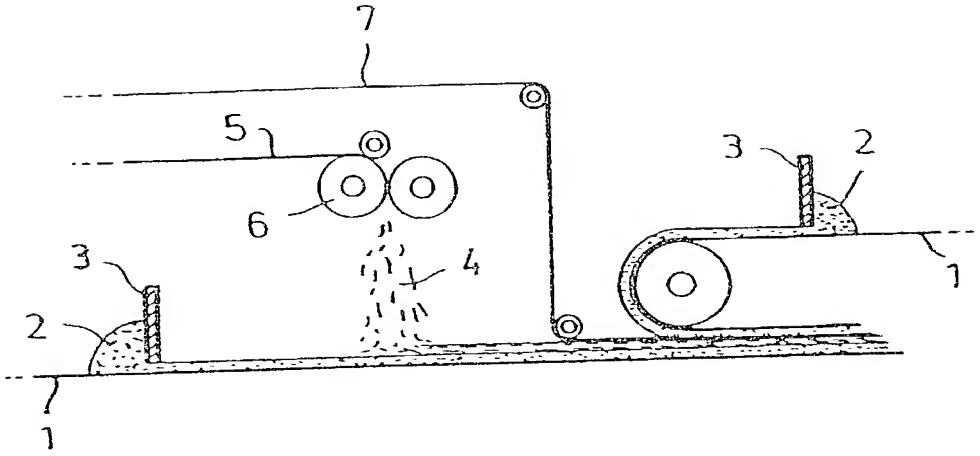

FIG.1

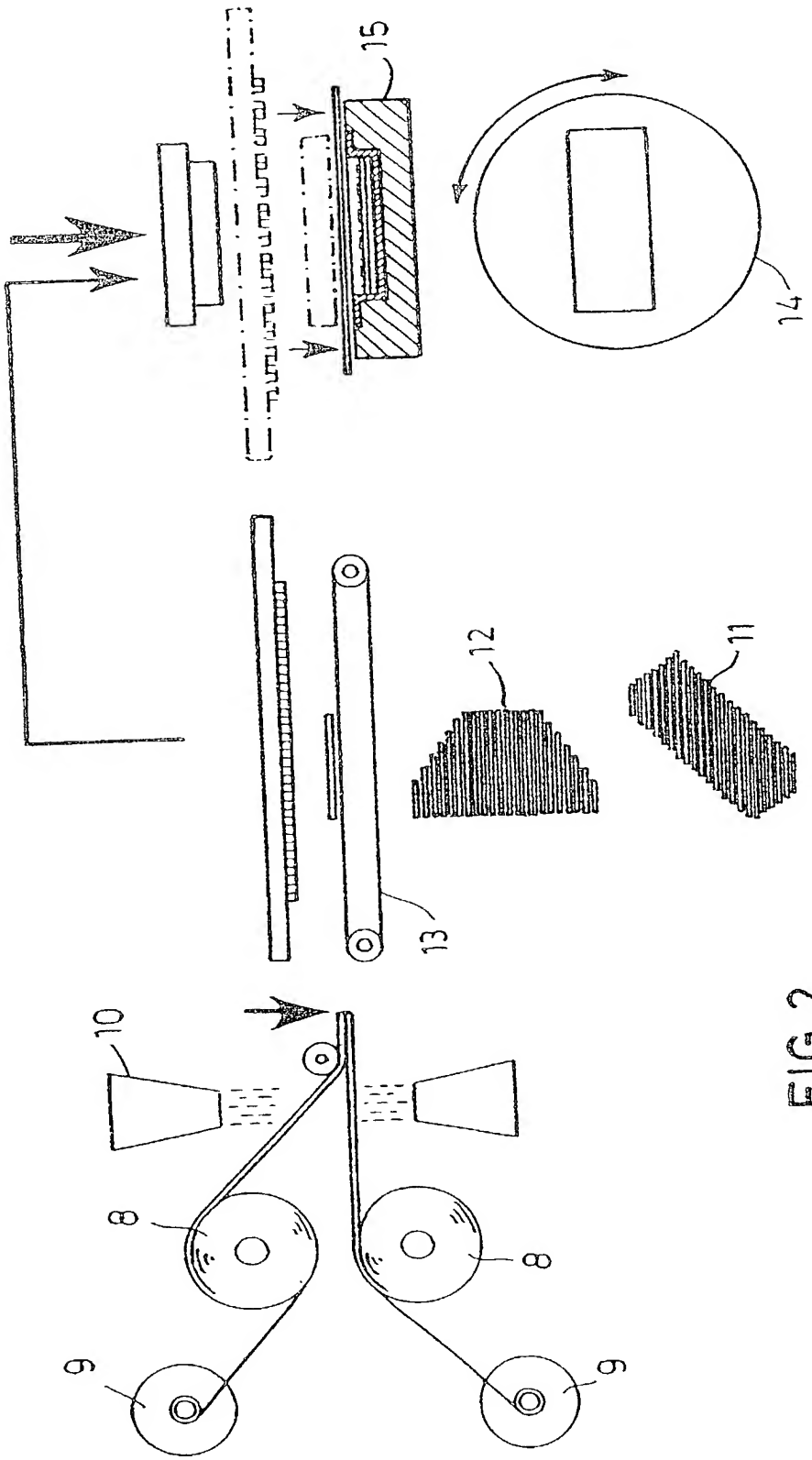

FIG.2

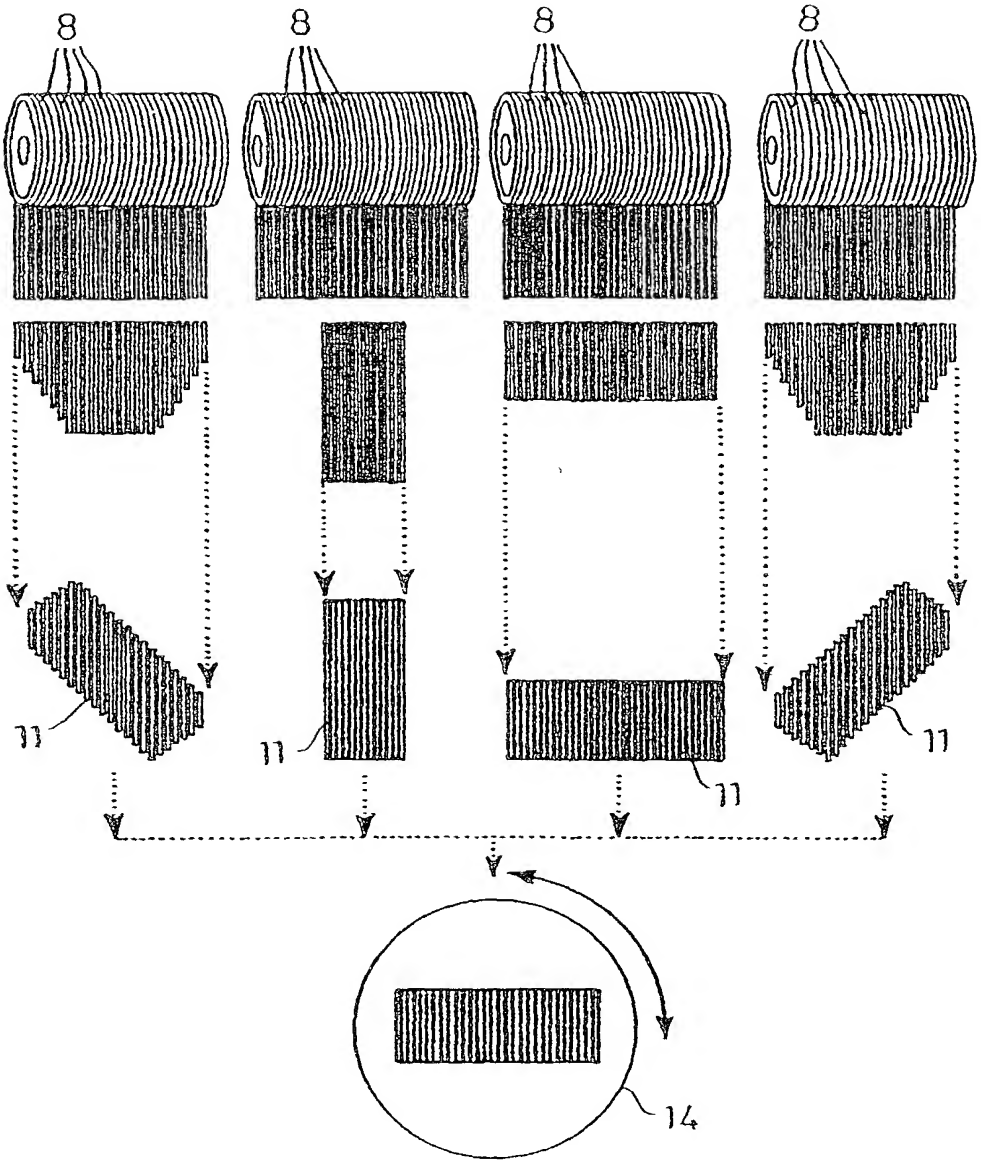

FIG.3

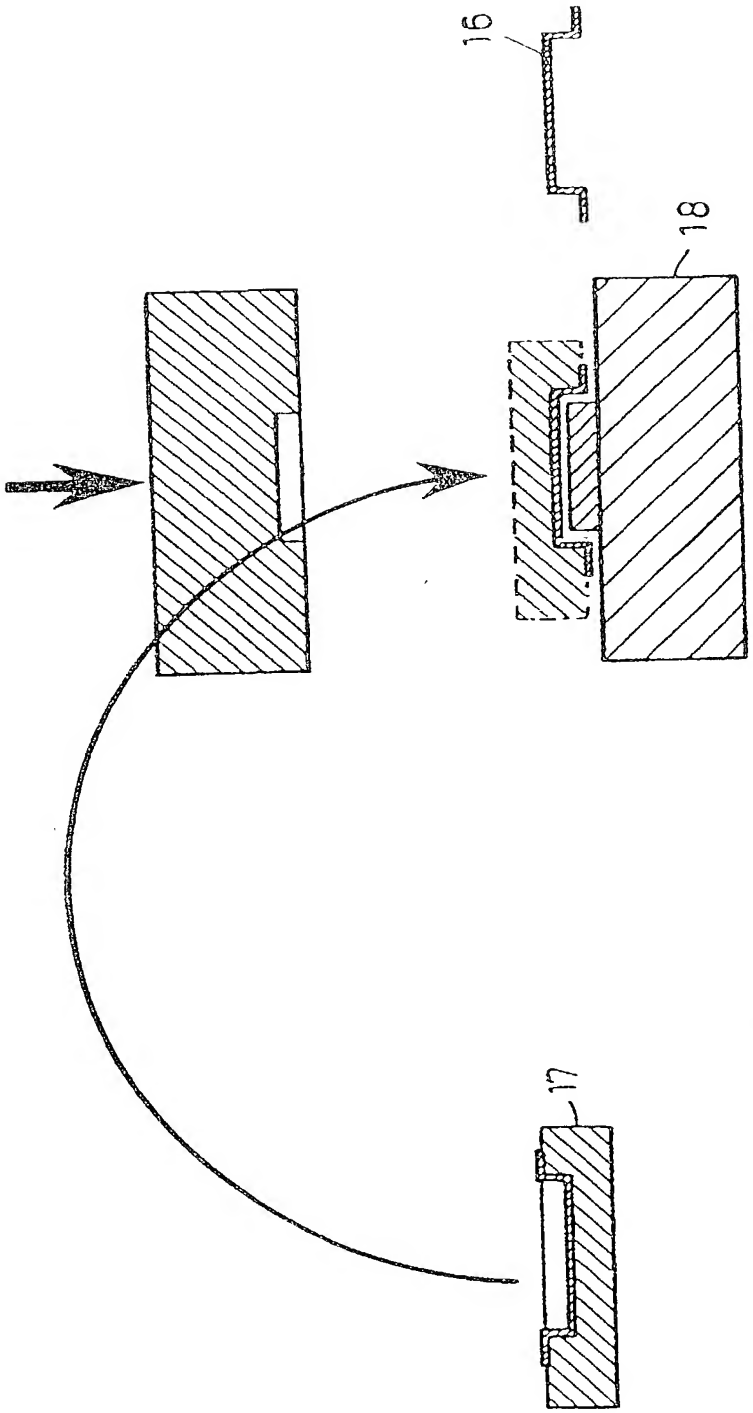

FIG. 4

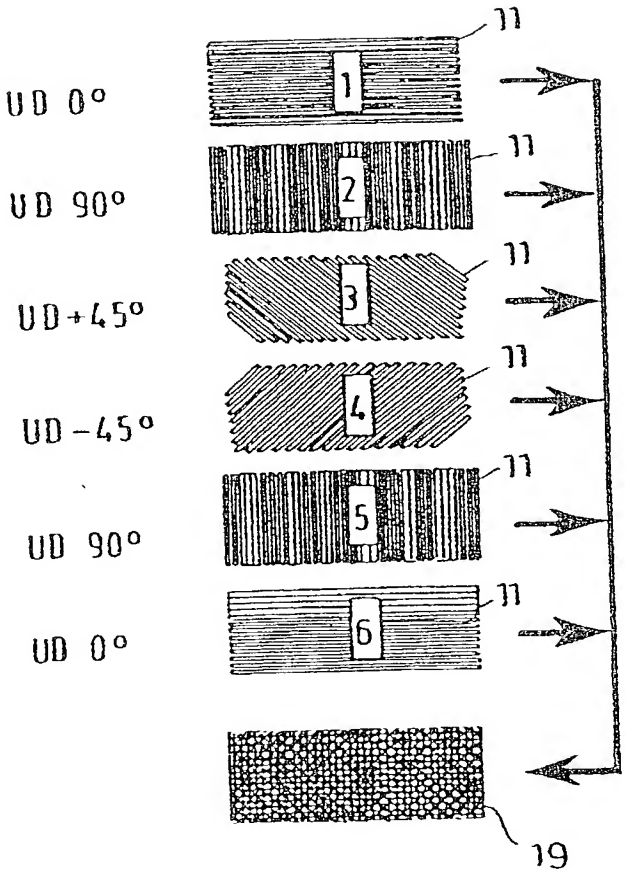

FIG. 5

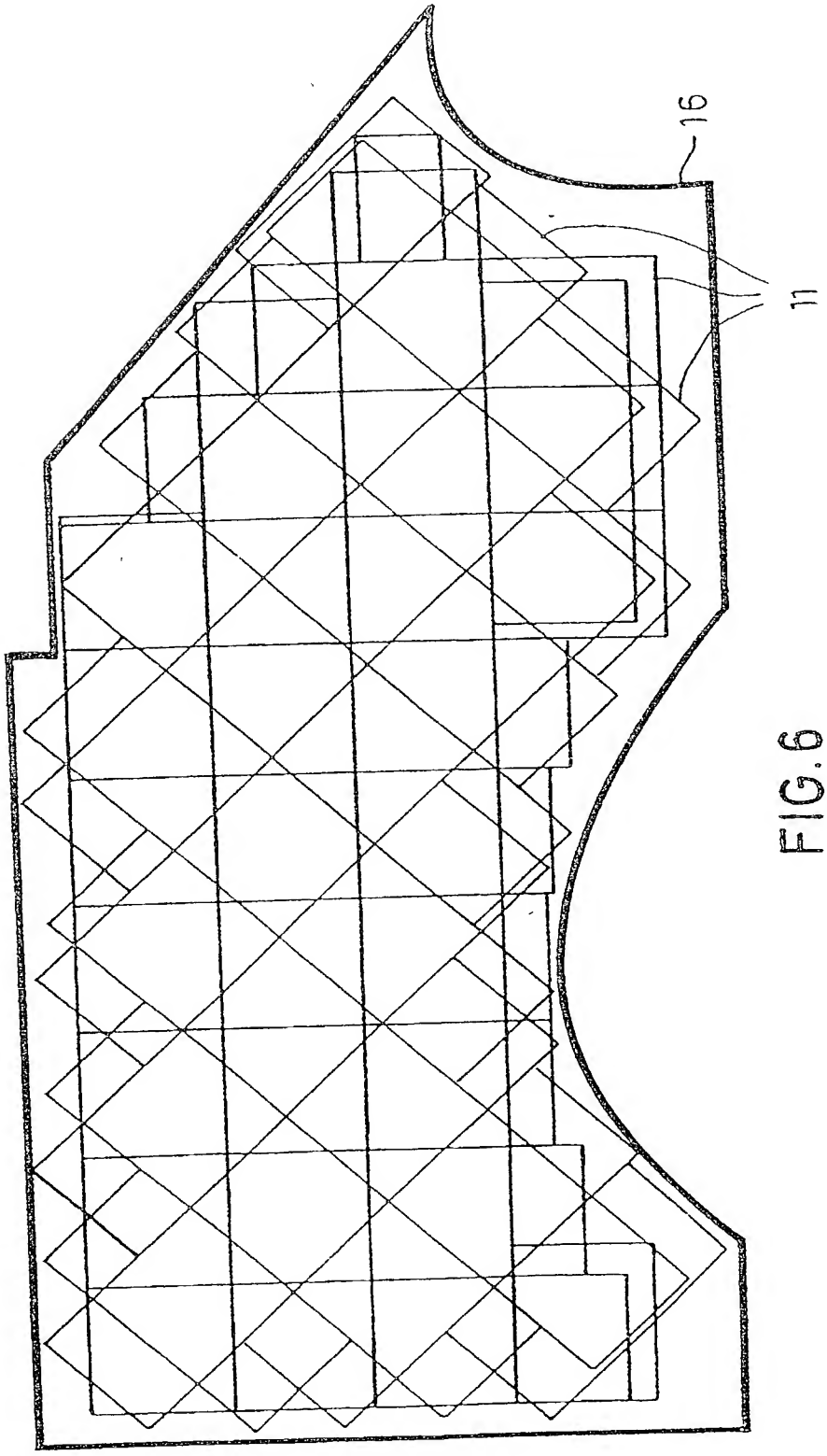

FIG.6

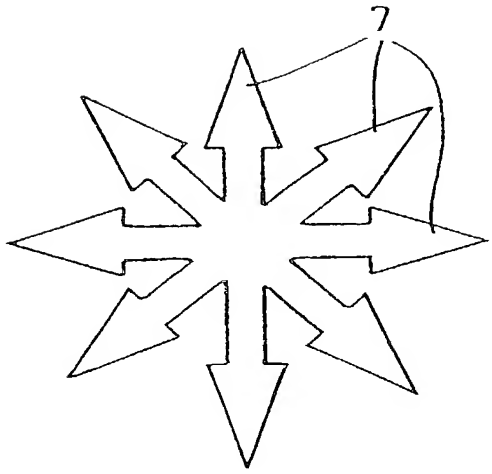

FIG .7

Attorney's Docket No.: 306.41247X00

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that: my residence, post office address and country of citizenship are as stated below, next to my name; I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **CARBON-FIBRE-REINFORCED SMC FOR MULTI-AXIALLY REINFORCED CONCEPTS**

the specification of which

___ is attached hereto.

_X_ was filed on March 1, 2002 as
United States Application Number 10/069,877
or PCT International Application Number PCT/EP00/08427
and was amended on _____.
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
199 43 442.5 (Number)	DE (Country)	11/September/1999 (Day/Month/Year Filed)	___ Yes	___ No
199 49 318.9 (Number)	DE (Country)	13/October/1999 (Day/Month/Year Filed)	___ Yes	___ No

I hereby claim the benefit under title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below

_____ (Application Number) _____ Filing Date

_____ (Application Number) _____ Filing Date

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

Attorney's Docket No.: 306.41247X00

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As a below named inventor, I hereby declare that: my residence, post office address and country of citizenship are as stated below, next to my name; I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **CARBON-FIBRE-REINFORCED SMC FOR MULTI-AXIALLY REINFORCED CONCEPTS**

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Title 37, Code of Federal Regulations, Section 1.56
Duty to Disclose Information Material to Patentability

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclosure information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclosure all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by 991.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) Prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) The closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to parentability when it is not cumulative to information already of record or being made or record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application;

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.

(Application Number)	Filing Date	(Status -- patented, pending, abandoned)
(Application Number)	Filing Date	(Status -- patented, pending, abandoned)

I hereby appoint: Donald R. Antonelli, Reg. No. 20,296; Melvin Kraus, Reg. No. 22,466; William I. Solomon, Reg. No. 28,565; Gregory E. Montone, Reg. No. 28,141; Ronald J. Shore, Reg. No. 28,577; Donald E. Stout, Reg. No. 26,422; Alan E. Schiavelli, Reg. No. 32,087; James N. Dresser, Reg. No. 22,973; Carl I. Brundidge, Reg. No. 29,621; Paul J. Skwierawski, Reg. No. 32,173; and Robert M. Bauer, Reg. No. 34,487, my attorneys; of ANTONELLI, TERRY, STOUT & KRAUS, LLP with offices located at 1300 North Seventeenth Street, Suite 1800, Arlington, Virginia 22209, telephone: (703) 312-6600, fax: (703) 312-6666; with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

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TEL: (703) 312-6600
FAX: (703) 312-6666

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1 00

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Inventor's Signature _____ Date 05.06.02

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Full Name of Second/Joint Inventor Klaus BIENIEK

Inventor's Signature _____ Date _____

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Post Office Address Talstrasse 5, D-75438, Knittlingen-Hohenklingen, Germany DEX

Full Name of Third/Joint Inventor _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____

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Inventor's Signature _____ Date _____

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Full Name of Second/Joint Inventor Klaus BIENIEK

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(City, State) (Country)

Post Office Address _____

_____

Full Name of Fourth/Joint Inventor _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____

(City, State) (Country)

Post Office Address _____

_____

Full Name of Fifth/Joint Inventor _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____

(City, State) (Country)

Post Office Address _____

_____

Full Name of Sixth/Joint Inventor _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____

(City, State) (Country)

Post Office Address _____

_____

Full Name of Seventh/Joint Inventor _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____

(City, State) (Country)

Post Office Address _____

_____

Full Name of Eight/Joint Inventor _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____

(City, State) (Country)

Post Office Address _____

_____

Full Name of Ninth/Joint Inventor

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____

(City, State) (Country)

Post Office Address _____

_____

Full Name of Tenth/Joint Inventor

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____
(City, State) (Country)

Post Office Address _____

_____